

UNDERSTANDING PLACE-VALUE

A case study of the base ten game

The initial objectives of this project were to research approaches for improving students' mathematical learning outcomes in relation to the base ten number system and methods for tracking students' understanding of number within a whole class setting. The research also aimed to explore the strategies that support the learning of each student as he or she progresses to the next stage of understanding of the number system.

The research attempted to build upon the work of previous studies that explored ways teachers could more actively assist students to develop their understanding of the structure of the number system. The project explored the role of a commonly used teaching activity, referred to in the project as the 'base ten game', in developing children's understanding of our number system. The game involves students using a place value board and concrete materials to develop an understanding of the structure of the number system and to learn to operate on numbers using this structure.

To play the most basic version of the game, the student rolls two dice, adds the numbers shown, and collects that quantity of pop-sticks to add to their game-board, which is ruled up into place value columns (see Figure 1). The only rule of the game is that there can be no more than nine items in any one column. Once there are nine sticks in the units

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Association of Independent
Schools reports findings
from a project designed to
explore approaches for
improving students'
mathematical learning
outcomes in relation to the
Base Ten number system.

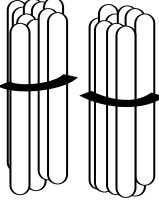
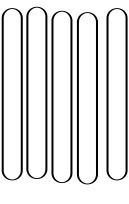
Thousands	Hundreds	Tens	Units
			

Figure 1. Game board showing 25 pop-sticks.



Figure 2. Using 0–9 digit cards on rings to support learning about how numbers are written.



Figure 3. A Year 5 student using four dice to explore continuous addition of larger numbers through the base ten game.

column, the tenth stick is combined to make a bundle of ten sticks which is then placed in the tens column. Rubber bands can be used to hold the bundles of sticks together. The only rule of the game is that there can be no more than nine in any one column, that is, in the units column there can be no more than nine sticks, in the tens column there can be no more than nine bundles of ten sticks, in the hundreds column there can be no more than nine bundles of 100 sticks, and so on.

The project was undertaken using a model of action research, involving nine teachers. The teachers selected to participate in this study had all previously undertaken extended professional development to incorporate constructivist learning theories in their teaching, and the teachers were keen to explore the use of concrete materials, especially the base ten game in relation to student learning.

The five project schools represented the diverse range of communities within the independent sector, including an isolated rural school with high numbers of Indigenous students, small and large urban schools, and two schools with high numbers of students from a low socio-economic background. The research took place between March and October of 2001, and involved approximately 280 primary students.

The research methodology enabled the teacher researchers to focus on improved student learning through changes in teacher practice and allowed concentration on the practical, day-to-day realities of the classroom. Under the broad question, 'What are the most effective teaching methods and management structures that will maximise the learning of the base ten number system in a whole class setting?' each teacher developed their own specific research question. Within the parameters of each individual research question were common elements of investigation that included:

- the range of teaching and learning strategies that were employed to enhance base ten learning;
- monitoring and evaluation of these strategies;
- teacher knowledge that was required to effectively help students learn; and
- the use of concrete materials to assist learning.

Throughout the project the teacher researchers were guided by a Project Officer, Mrs Andrea Broadbent. The

teacher researchers came together for professional development and sharing of experiences, received visits to their schools, and kept reflective journals and student work samples. Each teacher reflected upon their learning and wrote a report of their learning journey. A final research report, drawing together common elements was constructed.

The major findings from this project are listed below.

- Teachers needed to develop their own knowledge of the base ten number system before they could help students learn. The teachers' own understanding of the number system improved when they focussed on features of the number system that they wanted their students to learn. By clarifying the desired learning outcomes, the project teachers were better able to identify children who were having difficulty, and plan appropriate learning experiences for these children. Professional development which focussed on the children's conceptual understanding was likely also to assist teachers to develop their own understandings.
- Once teachers had developed their own relational understanding of the number system, they were better able to:
 - discover what each student already knew about base ten;
 - diagnose any misconceptions that a student may have developed;
 - offer learning activities that enabled students to build their knowledge;
 - adapt learning activities to meet the individual learning needs of the diversity of students in the class.
- Concrete materials, such as those used in the base ten game, can make a significant contribution to the development of students' conceptual and procedural knowledge about the number system across all year levels.
- Any one set of concrete materials or any one teaching activity highlights only certain aspects of the number system. A deep understanding requires a range of materials and activities, chosen according to the features of the number system that they highlight.
- The base ten game is a valuable core activity for students of all year levels who are still trying to make sense of the structure of the number system. Its usefulness will be enhanced by the addition of complementary activities which both support the ideas being developed through the base ten game, and which look at the same ideas in a different way.

This project revealed the necessity of explicitly developing links between the concrete materials, the learning activities and the structure of the number system to support the development of relational understanding of place-value.

Reference

Pengelly, H. (1991). *Understanding the Structure of the Number System*. Sydney: Ashton Scholastic.